N Sentinel: Nitrogen Monitoring for Higher Yields and Greater Nitrogen Use Efficiency

Purpose:

Ontario corn farmers continue to apply the majority of the crops nitrogen (N) needs prior to planting as a broadcast and worked in application of urea and to a lesser extent urea ammonium nitrate (UAN). Little if any management decisions other than yield goal target are used in the selection of N rates.

Significant advancements in nitrogen management can be made if we improve upon the current tools used for estimating fertilizer N requirements (Corn N Calculator, Pre-Sidedress Nitrate Testing, manure nutrient analysis, etc.) This improvement can be made by addressing the seasonal or weather impacts on both soil nitrogen supply and crop demand.

In previous years OMAFRA Field Crop Unit staff in partnership with producers, agri-business and SGS labs has conducted an annual one day survey of soil N levels across the province. While this has been of value to a range of users, the single day nature of the soil N levels has limited use as a single point in time measurement when soil N dynamics change quickly with time and climatic conditions.

The ongoing intensive monitoring of soil N levels over the early-mid growing season at a number of dedicated locations with up to the minute weather reporting to enable the soil N results to be explained in relation to the weather was thought to be a better way to assess soil N dynamics.

Methods:

The key elements of this 3 year project include:

A) 20 N Monitoring Fields

1. Establish a network of 20 Nitrogen Monitoring Fields across the province that will serve as a gauge for growers to evaluate how seasonal forces are influencing nitrogen requirements.
2. Use multiple soil nitrate sampling dates to more accurately reflect soil N supply at these sites
3. Use detailed weather information to validate N status and crop demands, (i.e. previous research indicated that if growers maintained accurate rainfall records for each corn field from April 10 to June 10 significant adjustments to N rates could be made that enhanced profitability and nitrogen balance).

B) Website for Real Time N Monitoring

4. Post all of the project information on the internet for growers to do real-time evaluations of N status and recommendations at these various sites

C) Evaluate New OMFRA Recommendation Tools

5. Allow growers to evaluate the new OMAFRA recommendation tool which for the first time (March 2015 launch) will integrate the N Calculator with a revised Soil Nitrate testing procedure.
6. The 20 N Monitoring Fields will include various N rates and yield responses to be able conduct end-of-season evaluations on the accuracy of recommendations.

In 2015, 8 sites were established in collaboration with UG Corn Research Groups at Ridgetown, Guelph and Winchester. Two replicate treatments of zero and non-yield-limiting N rate were applied for two hybrids. The required treatments were added to the Ontario Corn Committee (OCC) Corn Performance Trials.

Weather INNovations (WIN) of Chatham Ontario partnered on the project and installed automatic weather stations at each location to record weather data continuously over the season.

Soil samples were collected from each zero N plot at each location on a biweekly basis starting in mid may. Eight cores were collected to a depth of 30cm (12"), composited well and packed into soil sample boxes from SGS Labs. Samples were kept cool during transport, held in cooled storage overnight and submitted to SGS labs for nitrate and ammonium assessment.

Results:

Soil N rates varied widely by location and time during the sampling period. Alma and Exeter values are higher then one would expect (Table 1). Alma was do to an application error where the test area received commercial fertilizer application when it wasn't supposed to. At Exeter, the site was previously winter wheat with a good crop of red clover that was plowed down and obviously supplied added mineralized N.

Table 1. Soil N Concentration (ppm) by Timing and Crop Stage Over Location

	Soil Nitrate Sampling Timing				
	1	2	3	4	5
Date Range by Site	May 1-7	May 21-29	June 4	June 11	June 23-25
Leaf Over Corn Stage	Pre-emerge	1-4	4-7	7-8	10-12
Location	------------------------- *soil nitrate (ppm)* -------------------------				
Alma	22.9	19.4	19.5	24.6	64.9
Belmont	11.2	20.0	18.0	19.5	13.7
Dresden	8.7	8.7	36.6		13.5
Elora	9.2	12.2	13.0	21.0	13.7
Exeter	5.3	26.6	19.6	24.1	18.0
Ridgetown	9.3	12.3	25.2		13.2
Waterloo	4.8	9.1	10.5	13.0	8.6

In general note the trend of low initial soil N ppm levels and then building with time, temperature and moisture as the spring progressed. Also note that wet weather in June appears to have reduced the soil N supply towards the later part of the month, just when the crop is really in need of ready access to this nutrient.

Table 2a+b. N Rates and Yield Responses with Delta Yield Estimates and MERNs by Location by Two Hybrids

Hybrid A							
Location	Hybrid	Nitrogen Rate		Corn Yield		Delta Response	
		Low N Rate	High N Rate	Low N Yield	High N Yield	Delta Yield	DY N Rec
		------ lb-N/ac ------		----------- yield (bu/ac) -----------			lb-N/ac
Alma	DKC38-03	13	170	206	238	32	98
Belmont	Maizex MZ4107SMX	10	208	160	232	72	140
Dresden	Maizex MZ 4525 SMX	10	213	167	272	105	169
Elora	DKC38-03	7	170	152	222	70	134
Exeter	Maizex MZ4107SMX	10	190	191	217	26	86
Ridgetown	Maizex MZ 4525 SMX	10	206	170	250	81	147
Waterloo	MZ3484SMX	7	200	115	247	132	189
Hybrid B							
Location	Hybrid	Nitrogen Rate		Corn Yield		Delta Response	
		Low N Rate	High N Rate	Low N Yield	High N Yield	Delta Yield	DY N Rec
		------ lb-N/ac ------		----------- yield (bu/ac) -----------			lb-N/ac
Alma	P9188AM	13	170	193	219	26	89
Belmont	Pride A7270G8	10	208	177	230	54	121
Dresden	Pioneer P0216AM	10	213	160	247	87	153
Elora	P9188AM	7	170	128	187	59	124
Exeter	Pride A7270G8	10	190	193	235	41	107
Ridgetown	Pioneer P0216AM	10	206	140	251	112	175
Waterloo	P9224AM	7	200	116	229	112	173

Table 2 summarizes the fertility levels and yield responses observed at each site. The low N plots at each location had less than 15 lbsN/ac of applied fertilizer N. The non yield limiting fertilizer rate ranged from 170 to 213 blsN/ac. Note the wide range in yield response between the low and high N treatments by location. This highlights the site specific nature of N needs by location, soil type, previous crop and other factors. It suggests that the use of a standard N application rate across all fields is not likely to be economically or environmentally a sound practice. N rates need to be carefully considered for each field situation each year.

In interpreting the results note the Delta yield difference between the low and high N rate plot yields. The greater this number the higher the response to N fertilization and the greater the MERN rate of N that is needed to maximize economic returns. Where there is less yield difference between the low and high N rate plots suggests that the natural N pool is contributing a significant amount of available N to the growing crop and thus the response to added commercial N will not be as great.

Weather data from automated weather stations was summarized and reported by WIN. An example of the data provided is shown in Figures 1 and 2. Figure 1 reports temperature and rainfall deviations from the long term average weather data by site. As an example at the Dresden location note the cool June and July and the wet mid June to early July period which likely reduced mineralizable N levels in the soil during this period.

Figure 1. Weather Data Collected by Site Automated Weather Station

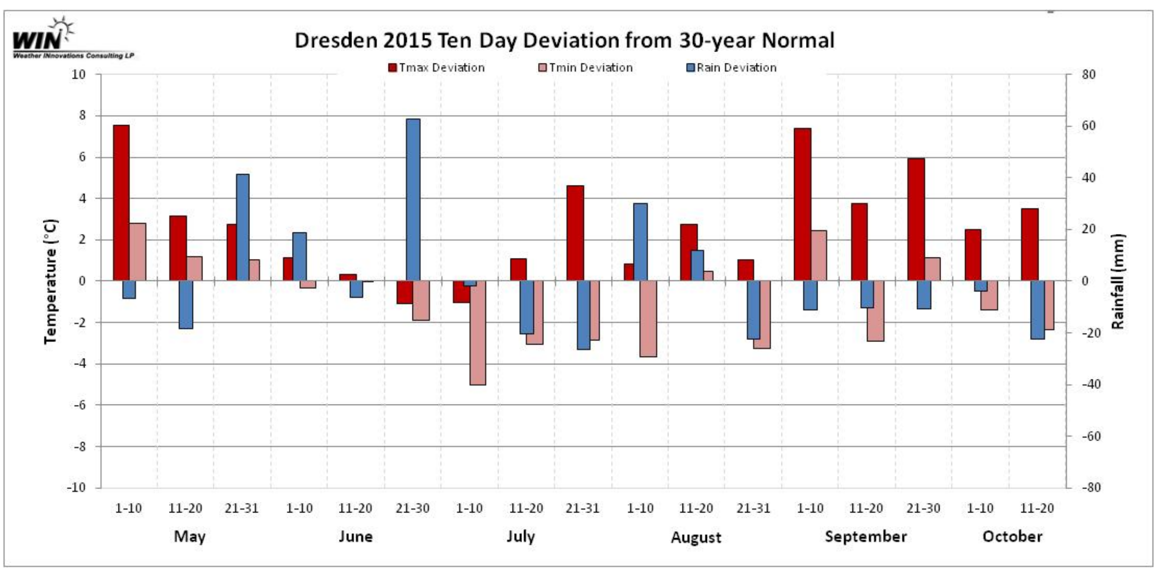
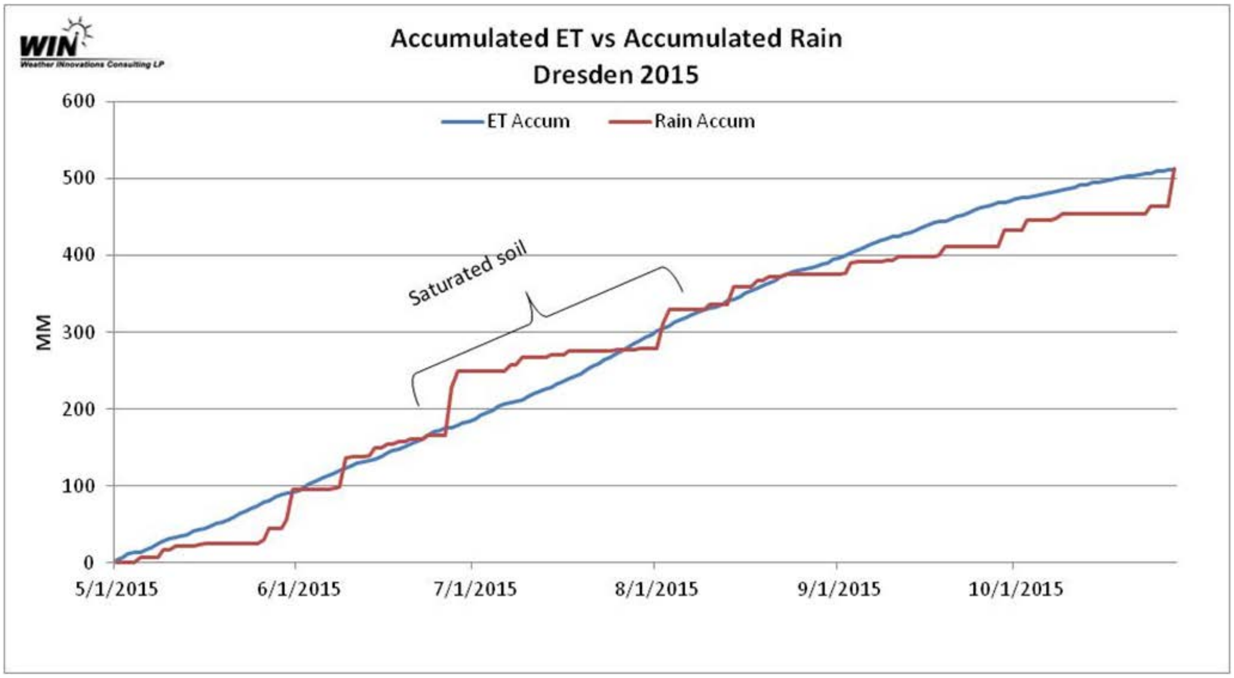


Figure 2 as an example again from Dresden, points out the wet soil conditions in Early July but he steady accumulation of ET despite the weather.

Figure 3. Rainfall and Accumulated Evapotranspiration By Site for Growing Season 2015



Summary:

Weather is obviously an important variable in impacting the amount of mineralizable N available to the growing corn crop and impacts the amount of commercial fertilizer N that must be supplemented to meet crops needs. The expansion of sites and a better feel for the operational aspects of the project should see a more complete storey evolve over the next two years.

Next Steps:

This project will continue in 2016 and 2017, expanding from the 2015 8 sites to 20 sites with ongoing weather monitoring and soil N sampling.

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Location of Project Final Report: